Many studies of seizure outcome following epilepsy surgery have been done and more recently, the impact on health-related quality of life has been assessed. However, the postoperative management of antiepileptic drug (AED) treatment which impacts on both of these outcome measures has largely been ignored in the literature. This article reviews the existing information on both immediate and longterm treatment with antiepileptic drugs (AEDs) following epilepsy surgery, particularly temporal lobectomy, and suggests possible management strategies.

Changes in Antiepileptic Drugs in the Immediate Postoperative Period

Seizures which occur in the first postoperative week have little if any impact on prognosis of seizure outcome. However, the psychological effect of such immediate seizures when the patient’s expectations are high, can be serious. There are many reasons why seizures might occur in the few days or weeks after surgery including direct cortical irritation from the operative procedure and the general stress of undergoing surgery. It is not known if reduction of AEDs, which may occur preoperatively during investigation with EEG telemetry to record seizures or, in some patients, immediately after surgery, increases the risk of early postoperative seizures. Our experience suggests that it is not a major contributing factor. On the other hand, the decrease

particular susceptible to this effect. If such a change occurs, an increase in AED dose may be required; however, the blood levels should be followed so that a downward dose adjustment can be made once the postoperative effect has disappeared. Otherwise, the patient could develop drug toxicity once the postoperative destabilizing effect has worn off. Another change in the first postoperative week which has been reported is carbamazepine toxicity caused presumably by a slowed rate of metabolism for the drug as well as its metabolite, carbamazepine-10-11-epoxide. This has not occurred in our series, but it could be counteracted by a number of factors in surgically treated patients which increase the likelihood of recurrence, including syndromes with partial seizures, longstanding intractability before seizure control, polytherapy and in some cases, occurrence of generalized tonic clonic seizures.

Many factors influence the decision to withdraw AEDs including age at surgery, seizure outcome, drug side effects, potential teratogenicity, results of preoperative investigation (i.e. unifocal vs. multifocal abnormalities, temporal vs. extratemporal), whether the patient is driving, employment and individual patient preference. Consideration must also be given to the type of epileptic syndrome being treated and its prognosis. For example, one would be more cautious withdrawing AEDs in patients who have had extratemporal resection and when preoperative investigation showed evidence of multiple foci or a larger epileptic zone than was resected. There is a lack of consensus as to the value of postoperative electroencephalography or electrocorticography in predicting seizure recurrence. Some would argue that the presence of epileptiform transients predicts a poor clinical outcome but others dispute this. Since the aim of the majority of patients is to be off antiepileptic drugs completely, those who are seizure-free will usually want to try stopping medication at some point after surgery.

Polytherapy has been associated with an increased frequency of side effects and poor drug compliance. However, a recent study suggests that total drug dose may be more important than the number of AED’s. Despite a number of studies which emphasize monotherapy for the treatment of epilepsy, most patients considered for epilepsy surgery are on polytherapy. In the few studies which report antiepileptic drug outcome after epilepsy surgery, there appears to be a trend over time from polytherapy to monotherapy after surgery. Wieser reported on 52 patients with a minimum one year follow-up after amygdalo-hippocampectomy, in whom 52% were still on polytherapy, 27% were on monotherapy and 21% on no antiepileptic drugs. Similarly, data from one of our centres on 72 patients following temporal lobectomy found that polytherapy decreased from 80% of patients preoperatively to 20% two years postoperatively. In a series of 124 adults, with mean follow-up of 16 years after epilepsy surgery for partial epilepsy including both temporal and extratemporal resections, 51% remained on polytherapy compared to 23% on monotherapy and 26% who had discontinued medication. More recently, Vickrey et al found after a mean follow-up of 5.8 years that the mean number of AEDs used per patient fell from 2.28 preoperatively to 1.36 postoperatively following temporal or extratemporal resection. Interestingly, in the two controlled studies of epilepsy surgery, there is a less striking but definite decrease in the use of antiepileptic drugs by patients with intractable epilepsy who did not have surgery and were followed for the same length of time. One study of children undergoing temporal or extratemporal resections has found that at a mean follow-up of 2.7 years, 30% had discontinued antiepileptic drugs while another 30% were on “reduced medication”.

We have carried out a retrospective study of 93 patients who had temporal lobectomy and were followed at 6, 12, and 24 months after surgery. Figure 2 shows the percent of patients on polytherapy, monotherapy or no AED treatment at the four time intervals. There was a striking reduction in patients on

in AED blood levels, despite stable drug doses which can follow epilepsy surgery (Figure 1) may lead to breakthrough of seizures. Why this occurs is unknown but several mechanisms have been suggested including accelerated AED metabolism caused by the stress of surgery, changes in bioavailability related to anesthesia or interaction with perioperative drugs such as steroids and antibiotics. Phenytoin and carbamazepine are particularly susceptible to this effect. If such a change occurs, an increase in the AED dose may be required; however, the blood levels should be followed so that a downward dose adjustment can be made once the postoperative effect has disappeared. Otherwise, the patient could develop drug toxicity once the postoperative destabilizing effect has worn off. Another change in the first postoperative week which has been reported is carbamazepine toxicity caused presumably by a slowed rate of metabolism for the drug as well as its metabolite, carbamazepine-10-11-epoxide. This has not occurred in our experience but we do not routinely measure AED blood levels postoperatively. This is done only if seizures occur or the patient experiences unexpected symptoms.

**LONGTERM POSTOPERATIVE MANAGEMENT**

Should it be easier to withdraw AEDs in patients who have had epilepsy surgery compared to those who have not? Theoretically, the answer is yes, since in most patients the cortex responsible for ictal discharge has been removed along with any causative pathology. However, no postoperative studies have been done to support this assumption. In medically treated epilepsy, withdrawal of AEDs has been assessed but remains controversial. After two years remission, AED withdrawal results in seizure recurrence in approximately 30-40% of patients. Although surgery should reduce this rate, this effect could be counteracted by a number of factors in surgically
polytherapy from 78% before surgery to only 14% at two years follow-up. Treatment with monotherapy went from 20% to 42% and medication was discontinued in 44% of patients. The most commonly used drugs, both before and after surgery, were carbamazepine, phenytoin and clobazam (Figure 3). The number of patients using both carbamazepine and clobazam dropped considerably following surgery but interestingly, there was little change in the group using phenytoin. This may reflect a concern in these patients about recurrence of generalized tonic clonic seizures. Although the number of AEDs used decreased significantly after surgery, there was no difference in the daily doses of the remaining drugs (Figure 4).

As expected, the postoperative AED use reflected degree of seizure control with 53% of seizure-free patients having discontinued AEDs compared to only 33% who continued to have at least some seizures. This is similar to unpublished data from the University of Washington discussed by Andermann et al.12 Four to five years after temporal resection, 67% of their seizure-free patients were on no AEDs compared to 50% with five or fewer seizures per year and 7% with more than five seizures per year. Thus, about a third to a half of patients still appear to require AEDs to remain seizure-free after surgery, most with monotherapy. That a third of patients who remain uncontrolled elect not to take medications is not surprising, since many of these patients have a considerable decrease in severity, as well as frequency of postoperative seizures.

**TIMING OF POSTOPERATIVE ANTIEPILEPTIC DRUG CHANGES**

Reduction and eventual withdrawal of AED treatment is one of the aims of epilepsy surgery but there are limited data to help determine when these changes should occur. Andermann et al suggest that no changes be made for “an arbitrary period of one year” and that cessation of AEDs be considered after two to three years.12 This is in line with withdrawal of medication following seizure control with medical management.10,11 Kuzniecky et al specifically addressed the timing of change in AED treatment following surgery in an open label, randomized trial of postoperative carbamazepine monotherapy versus polytherapy in 40 patients undergoing temporal lobectomy.26 Half the patients continued with presurgical polytherapy and half were changed to monotherapy at the time of surgery. Outcome determined at one year follow-up found that seizure recurrence was no different in the two groups but those on polytherapy had three times the incidence of drug-related side effects. The prevalence of side effects in this study is consistent with what has previously been reported with general medical management.27 Our data support their findings, since most of our patients were reduced from polytherapy to monotherapy within six months of surgery with no apparent impact on seizures.

Although early reduction in the amount of medication appears to be a reasonable approach, it is less clear when AEDs should be discontinued. Our study found that cessation of therapy one to two years after temporal lobectomy was not associated with untoward effects on seizures but this was a qualitative not quantitative assessment. However, the argument...
can be made that if a patient is seizure-free on a single AED such as carbamazepine, without side effects, why “rock the boat”? In other words, why risk having a seizure when someone is doing well. Unfortunately, there are no data to allow physicians to present the risk of seizure recurrence if AEDs are stopped following surgery. This is one explanation why 47% of our seizure-free patients were still on medication two years after surgery. We do not recommend stopping AEDs prior to one year follow-up but after that, patients should be allowed to determine when they feel comfortable with discontinuing medication under the guidance of their neurologist.

**POTENTIAL IMPACT OF AED WITHDRAWAL**

The decrease from polytherapy to monotherapy which commonly occurs following epilepsy surgery is associated with a reduction in drug-related side effects and in our experience, is seldom associated with seizures in otherwise controlled individuals. If a seizure does occur, it is usually when AEDs have been withdrawn completely. For some patients, the recurrence of seizures after surgery can be psychologically distressing; thus patients must be prepared for the possibility of seizure recurrence including the chance of a generalized tonic clonic seizure. They should be told that in the event of a seizure, medication will be re-introduced usually with return to a seizure-free state. There may be rare instances in which seizure control cannot be re-established but this is not well documented. Another rare occurrence is the development of the first episode of status epilepticus in the months following surgery, possibly in part related to reduced medication. Finally, the new onset of pseudoseizures has been documented after surgery and these, of course, do not respond to changes in AED therapy.

**RECOMMENDATIONS**

Since there are few data from clinical studies of postoperative antiepileptic drug reduction, the following recommendations are based largely on empirical evidence from experience at our centers and apply mainly to patients undergoing temporal lobectomy. More specific guidelines hopefully will evolve from prospective trials of AED withdrawal after epilepsy surgery.

1. An early goal of resective epilepsy surgery is the reduction of polytherapy to monotherapy. If AEDs have been reduced during preoperative AED telemetry, we often leave the patient on the lower amount of medication if surgery is going to be carried out within a few days or weeks. This usually implies going from three to two or from two to one AEDs.

2. If monotherapy has been used preoperatively, either no change is made or in some cases, a slight lowering of dose can be initiated five or six days after surgery and prior to discharge from hospital.

3. If monotherapy has not been achieved at the time of discharge, a gradual reduction in medication can be started six months postoperatively until this goal is reached or a seizure occurs.

4. Patients on monotherapy who are seizure-free for one or preferably two years can be offered the opportunity to withdraw medication utilizing published guidelines for drug withdrawal following medical management.

5. For extratemporal resections and particularly other procedures such as corpus callosotomy, a more cautious approach in reducing AEDs is required since complete seizure control is less likely to be achieved than following temporal lobectomy. An exception to this is hemispherectomy for which postoperative monotherapy can often be used prior to complete drug withdrawal.

**REFERENCES**


22. Wieser HG. Selective amygdalohippocampectomy for temporal

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